

A Study on Third Generation Mobile Technology (3G) and Comparison among All Generations of Mobile Communication

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Abstract: The world wide revolution in mobile is changing our lives in terms of the way we work, learn and interact. In the past few decades, mobile wireless technologies have experienced 4 or 5 generations of technology revolution and evolution, namely from 0G to 4G. Current research in mobile wireless technology [1] concentrates on advanced implementation of 4G technology and 5G technology. In this paper, we review architecture and functionality of Third generation (3G) mobile technology and compare it with various existing generations of mobile wireless technology vis-à-vis in terms of their portals, performance, advantages and disadvantages. The paper throws light on the evolution and development of 3G mobile wireless technologies along with its speed, connected devices, components and related protocols. We also review the world wide used of 3G technology now and in future along with other technologies.

Keyword: 1G, 2G, 3G, 4G, 5G.

1. Introduction

3G is the third generation of mobile phone [2] [3] standards and technology and represents one of the biggest opportunities the business world has ever seen, increasing the potential of mobile Internet and opening up new revenue streams.

In 3G, mobile phones became mobile devices combining a camera, video camera, computer, stereo, MP3 player and radio into one device. Rich-media information and entertainment are available at anytime whenever there is a wireless network.

The first pre-commercial 3G network – branded as FOMA – launched in May 2001, by NTT DoCoMo in Japan. Following the first pre-commercial launch, NTT

DoCoMo again made history with the first commercial launch of 3G in Japan on October 1, 2001.

2. Evaluation of Mobile Generation

The nomenclature of the cellular wireless [1] generations (G) generally refers to a change in the fundamental nature of the service, non-backwards compatible transmission technology, and new frequency bands. New generations have appeared about every ten years since the first move from 1981 analog (1G) to digital (2G) transmission in 1992. This was followed, in 2001, by 3G multi-media support, spread spectrum transmission and peak throughputs of 200 kbit/s; and in 2011 by 4G, which refers to all-IP switched networks, mobile ultra-broadband (gigabit speed) access and multi-carrier transmission.

2.1. What is 1G

First generation refers to the analog “brick phones” and “bag phones” as they were first introduced for mobile cellular technology. Cell phones began with 1G and signify first generation wireless analog technology standards that originated in the 1980s. 1G was replaced by 2G wireless digital standards.

2.2. What is 2G

2G [2] emerged in late 1980s. It uses digital signals for voice transmission and has speed of 64 kbps. It provides facility of SMS (Short Message Service) and use the bandwidth of 30 to 200 KHz. Next to 2G, 2.5G system uses packet switched and circuit switched domain and provide data rate up to 144 kbps. E.g. GPRS, CDMA and EDGE.

2.3. What is 3G

3G [2][3] is the third generation of mobile phone standards and technology. Current 3G systems have been established through ITU's project on International Mobile Telecommunications 2000 (IMT-2000).

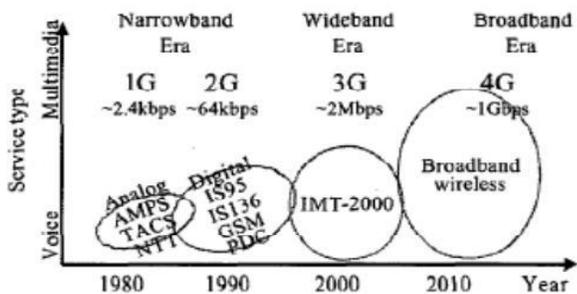


Figure 1: evolution of Mobile generation

3G technologies have enabled faster data transmission speeds, greater network capacity and more advanced network services. In May 2001, NTT DoCoMo (Japan) launched the first pre-commercial 3G network – branded as FOMA. Following the first pre-commercial launch, NTT DoCoMo again made history on October 1, 2001, with the first commercial launch of 3G in Japan. UMTS-HSPA is the world's leading 3G technology. By 2015, UMTS-HSPA and LTE 3G technologies are expected to account for 3.9 billion global subscriptions, compared to 569 million CDMA EV-DO subscriptions and 59 million WiMAX subscriptions.

2.4. What is 4G

4G [5] offers a downloading speed of 100Mbps. 4G provides same feature as 3G and additional services like Multi-Media Newspapers, to watch T.V programs with more clarity and send Data much faster than previous generations []. LTE (Long Term Evolution) is considered as 4G technology. 4G is being developed to accommodate the QoS and rate requirements set by forthcoming applications like wireless broadband access, Multimedia Messaging Service (MMS), video chat, mobile TV, HDTV content, Digital Video Broadcasting (DVB), minimal services like voice and data, and other services that utilize bandwidth.

2.5. What is 5G

5G Technology stands for fifth Generation Mobile technology. Fifth generation network provide affordable broadband wireless connectivity (very high speed). Currently 5G term is not officially used. In fifth generation researches are being made on development of World Wide Wireless Web (WWW), Dynamic Adhoc Wireless Networks (DAWN) and Real Wireless World. Fifth generation focus on (Voice Over IP) VOIP-

enabled devices that user will experience a high level of call volume and data transmission.

3. Evolution of 3G

3G is a global development of communication technologies and standards. As originally proposed, the idea behind 3G was to unify the different standards used in 2G wireless networks. Instead of different network types being adopted in the Americas, Europe and Japan, the plan called for a single network standard to be agreed on and implemented. Although it was fine in theory, in actuality, the International Telecommunication Union (ITU) sanctioned five terrestrial IMT-2000 standards in its 3G standardization process. The diagram below outlines the five IMT-2000 standards.

The ITU's IMT-2000 vision of a global family of 3G mobile communications systems include EDGE and UMTS, both of which 4G Americas supports for the success of operators deploying 3G services for the benefit of their customers.

3.1. Connected Devices

The spread of Mobile Broadband networks, the emergence of new mobile device categories and the expansion of mobile service propositions is establishing an "Internet of things" (IOT). Within the next decade, billions of new devices will be connected to mobile networks, providing consumers and businesses with an array of applications, services and experiences. This, we believe, will really usher in the "Connected Future" in which we are always connected, anywhere, and at any time.

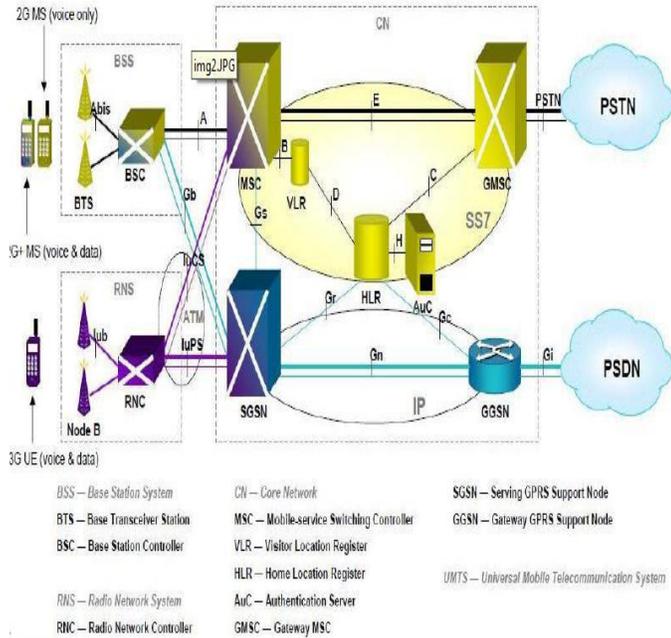


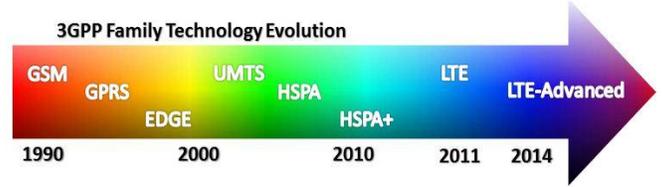
Figure 2: 3G Architecture

- **Connected Computing Devices are built around multimedia.** This category includes computing devices like tablets, laptops, and smartphones that help consumers browse the web, listen to music, and watch video.
- **Consumer M2M Devices are purpose-built and depend on the cloud.** This category includes consumer tracking and navigation devices, eReaders, and mHealth devices that run only a single application for consumers.
- **Enterprise M2M Devices service specific business needs.** Enterprise M2M devices include fleet telematics devices, digital signs, and smart grid terminals.

4. Evolution of Mobile Technology

4.1. GSM: Global System for Mobile Communications

GSM [4] is the legacy network of the evolution to the third generation (3G) technologies Universal Mobile Telecommunication System (UMTS), also known as WCDMA, and High Speed Packet Access (HSPA). Commonly referred to as the GSM family of technologies, the following diagram represents the evolution from second generation (2G) GSM and General Packet Radio System (GPRS) to 3G Enhanced Data for GSM Evolution (EDGE), UMTS and HSPA.



The oldest member of the GSM family of technologies is GSM itself; a digital or Personal Communications System (PCS), 2G technology that provides voice and circuit-switched data services.

There are several reasons why GSM is so popular among operators and their customers:

- **Clear voice quality,**
- **International roaming**
- **Spectral flexibility**
- **Tight security**
- **Data support**
- **Subscriber Identity Module (SIM) cards**
- **Product selection**
- **Research and development**

4.2. EDGE: Enhanced Data Rates For GSM Evolution

Enhanced Data Rates for GSM Evolution (EDGE) [4][6] is a third-generation (3G) technology that enables high-speed packet-data services such as Internet access and streaming multimedia. EDGE supports peak theoretical network data rates of 474 kbps, with average throughput of 70 to 130 kbps on both the downlink and the uplink. The average rates are fast enough to support a wide range of data services, including streaming audio and video, fast Internet access and large file downloads. EDGE also can support Push-to-Talk (PTT) services.

4.3. EDGE Evolution (EDGE II or Evolved EDGE)

EDGE Evolution, also called Evolved EDGE or EDGE II, is an upgraded version of EDGE technology that was ratified by the 3GPP in Release 7 (Rel-7). It applies many of the techniques employed in HSPA+ to lower latency and increase the speed of EDGE. A key part of the evolution of EDGE is the utilization of more than one radio frequency carrier. This is designed to overcome the inherent limitation of the narrow channel bandwidth of GSM.

4.4. EV-DO: Evolution-Data Optimized, or Evolution-Data Only

Evolution-Data Optimized or Evolution-Data Only is a wireless broadband standard within the CDMA2000 technology family. Code Division Multiple Access 2000 (CDMA2000), consisting principally of 1xEV-DO and One Carrier-Evolved, Data-Optimized (1xEV-DO) versions, is

the second most widely deployed cellular technology in the world. 1xRTT is the most widely deployed of the CDMA2000 family of technologies and is a CDMA operator's first step towards wireless data services. Often compared to GPRS or EDGE in the 3GPP family of technologies, 1xRTT has a further evolution to EV-DO.

4.5. Femtocells

Femtocells are low-power wireless access points – originally called Access Point Base Stations – that operate in licensed spectrum to connect standard mobile devices to a mobile operator's network using the customer's DSL or cable broadband connection. A femtocell is a scalable, multi-channel, two-way communications device that incorporates key elements of a mobile radio access network into a compact device – about the size of the typical desktop Wi-Fi router – and can be deployed in a home or office.

4.6. FMC: Fixed-Mobile Convergence

Fixed-Mobile Convergence (FMC) is a technology trend toward seamless connectivity between fixed and wireless telecommunications networks. FMC impacts almost all communications and information industries, promising great changes to the way customers consume communications services – anytime, anywhere and from any device. It is comprised of four key components – service, terminal, network, and industry convergence – all of which are interrelated and critical to the success of the others. Simply put, the aim is to provide both fixed and mobile telephony services with a single device or phone that can switch back and forth seamlessly.

4.7. HSPA: High Speed Packet Access

HSPA - High Speed Packet Access is the most widely deployed mobile broadband technology in the world today and will build upon the more than 6 billion connections with the GSM family of technologies. HSPA is the terminology used when both HSDPA (3GPP Release 5) and HSUPA (3GPP Release 6) technologies are deployed on a network.

4.8. HSDPA: High Speed Downlink Packet Access

HSDPA (High Speed Downlink Packet Access) is an upgrade to UMTS/WCDMA and has become the leading global mobile broadband standard, HSDPA increases the download speeds by up to 3.5 times, initially delivering typical user data rates of 550 to 800 kbps. Improvements to the downlink, through HSDPA, were the first upgrade steps available to operators seeking to

deploy mobile broadband services as a part of 3GPP Release 5.

4.9. HSUPA: High Speed Uplink Packet Access

High Speed Uplink Packet Access (HSUPA) [4] is an upgrade to UMTS-HSDPA that uses the Enhanced Dedicated Channel (E-DCH) to constitute a set of improvements to optimize uplink performance. These improvements include higher throughput, reduced latency and increased spectral efficiency. HSUPA was standardized in 3GPP Release 6 and combined with High Speed Downlink Packet Access (HSDPA), is commonly referred to as High Speed Packet Access (HSPA).

4.10. HSPA+: High Speed Packet Access Plus

HSPA+ (High Speed Packet Access Plus) is also known as HSPA Evolution and Evolved HSPA. HSPA+ was first standardized in 3GPP Release 7 and standardization has continued through to Release 10. HSPA+ will apply some of the techniques developed for Long Term Evolution (LTE) and allow operators to extend the life of their HSPA networks.

4.11. IMS: IP Multimedia Subsystem

The IP Multimedia Subsystem (IMS) is an architectural framework for delivering Internet Protocol (IP) multimedia services. It was originally designed by the wireless standards body 3rd Generation Partnership Project (3GPP), as a part of the vision for evolving mobile networks beyond GSM. IMS applications can reside either in the operator's network or in third-party networks.

4.12. LTE: Long Term Evolution

Long Term Evolution (LTE) is a radio platform technology that will allow operators to achieve even higher peak throughputs than HSPA+ in higher spectrum bandwidth. Work on LTE began at 3GPP in 2004, with an official LTE work item started in 2006 and a completed 3GPP Release 8 specification in March 2009. Initial deployments of LTE began in late 2009.

4.13. LTE-Advanced

LTE-Advanced is a term used for the version of LTE that addresses IMT-Advanced requirements, as specified in Release 10. LTE-Advanced is both backwards- and forwards-compatible with LTE, meaning LTE devices will operate in newer LTE-Advanced networks, and LTE-Advanced devices will operate in older LTE networks.

4.14. MIMO: Multiple-Input Multiple-Output

Multiple-Input Multiple-Output (MIMO) is an antenna technology – Sometimes called smart antenna

technology – that is used both in transmission and receiver equipment for wireless radio communication. MIMO uses multiple antennas to send multiple parallel signals (from transmitter).

MIMO can be used to advance such applications as:

- Streaming video, music
- Video surveillance
- Voice over Internet Protocol (VoIP)
- Video conferencing
- Interactive gaming
- Mobile TV

4.15. Mobile WiMAX

WiMAX, [4] or Worldwide Interoperability for Microwave Access, was a name created by the WiMAX Forum, which was formed in June 2001 to promote conformity and interoperability of the IEEE 802.16 technology standard. The forum describes WiMAX as a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL. WiMAX provides wireless transmission of data using a variety of transmission modes, from point-to-multipoint links to portable and fully mobile internet access. It should be noted that most often, references to WiMAX deployments and ecosystem announcements include the fixed, portable and mobile WiMAX technologies.

UMA is a global standard developed by the 3rd Generation Partnership Project (3GPP) in Release 6. UMA provides subscriber access to mobile wireless circuit, packet and IMS-based services over devices using IP-based networks, such as DSL, cable and Wi-Fi. UMA solutions promote seamless handovers, high levels of service transparency, and a relatively low-impact way of deploying converged services in a 2G or 3G network with the cost benefits of unlicensed spectrum and Internet backhaul. UMA also specifies seamless handovers between 2G and 3G GSM-HSPA radios and unlicensed access.

4.18. UMTS: Universal Mobile Telecommunications System, or WCDMA: Wideband Code Division Multiple Access

Universal Mobile Telecommunications System (UMTS) [6] is a voice and high-speed data technology that is part of the International Telecommunication Union’s (ITU) IMT-2000 family of third-generation (3G) wireless standards. Wideband CDMA (WCDMA) is the radio technology used in UMTS. As a result, the terms UMTS and WCDMA are often used interchangeably. UMTS is based on Internet Protocol (IP) technology with user achievable peak data rates of 350 kbps and more typical speeds for both the uplink and the downlink at 200 to 300 kbps.

UMTS operators can use a common core network that supports multiple radio-access networks, including GSM, EDGE, WCDMA, HSPA and evolutions of these technologies. This is called the UMTS multi-radio network and it gives operators maximum flexibility in providing different services across their coverage areas.

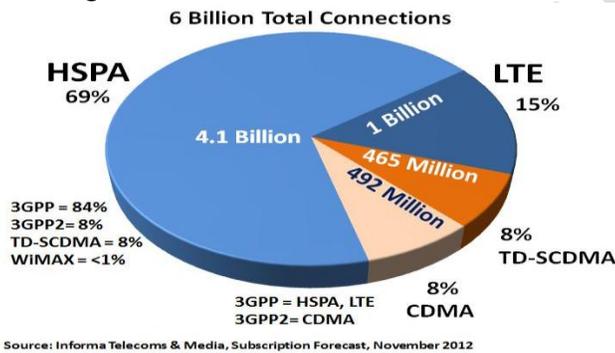


Figure 3: Vast used of WIMAX Technology

4.16. SAE/EPC: System Architecture Evolution/Evolved Packet Core

System Architecture Evolution, or SAE, is synonymous with Evolved Packet Core, or EPC. SAE/EPC is defined by 3GPP in Release 8 (Rel-8) as an entirely new core network with a flatter all-IP architecture enabling a higher data rate, lower latency packet-optimized system that supports multiple radio-access technologies, focusing on the packet-switched domain, with the assumption that the system will support all services – including voice – in this domain.

4.17. UMA: Unlicensed Mobile Access

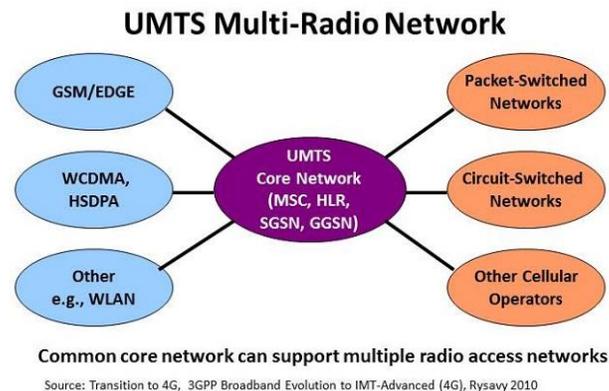


Figure 4: UMTS Network

4.19. Wi-Fi: Wireless Fidelity

Wi-Fi, or Wireless Fidelity, is a wireless local area network (WLAN) technology based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 family of standards, which includes 802.11a, b, g and n. There are several key differences between cellular and Wi-Fi. For example, Wi-Fi signals have a range of about 200 to 300 feet, while cellular GSM signals can travel for several miles. Wi-Fi also uses unlicensed spectrum, so unlike GSM, it has no inherent protection from interference.

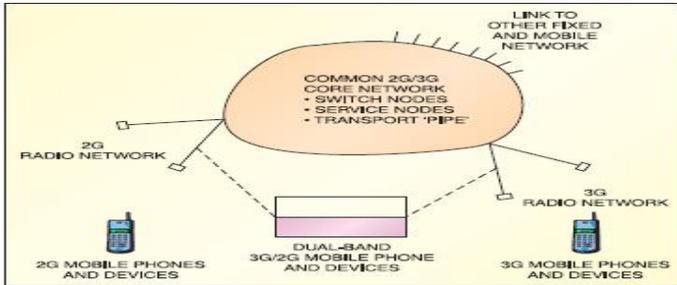


Figure 5: 3G Network

5. COMPARISON OF ALL GENERATIONS OF MOBILE TECHNOLOGIES

Here is the comparison table among all mobile generation [7] [8]

Technology → Features ↓	1G	2G	3G	4G	5G
Start/ Deployment	1970 – 1980	1990 - 2004	2004-2010	Now	Soon (probably 2020)
Data Bandwidth	2kbps	64kbps	2Mbps	1 Gbps	Higher than 1Gbps
Technology	Analog Cellular Technology	Digital Cellular Technology	CDMA 2000 (1xRTT, EVDO) UMTS, EDGE	WiMax LTE Wi-Fi	WWW(coming soon)
Service	Mobile Telephony (Voice)	Digital voice, SMS, Higher capacity packetized data	Integrated high quality audio, video and data	Dynamic Information access, Wearable devices	Dynamic Information access, Wearable devices with AI Capabilities
Multiplexing	FDMA	TDMA, CDMA	CDMA	CDMA	CDMA
Switching	Circuit	Circuit, Packet	Packet	All Packet	All Packet
Core Network	PSTN	PSTN	Packet N/W	Internet	Internet

Table 1: Comparison among 1G, 2G, 3G, 4G, 5G.

6. RESULT

The study was based on 3G mobile technology and a comparatively study among all generations architecture and the services. on various factor one generation stand better than the other in technical advancement, data speed and services 3G stand promising .In present day 3G provide best service but in high tariff as compared to 2G .As the advancement in generation goes the technology become more complex and band utilization increases.

7. CONCLUSION

The study shows though 2G provide services that are good and high data speed at low cost ,and call rates are at low tariff but the data speed is comparatively low .But 3G provide high rate of data access and some exclusive services that were not provided by previous versions like 3G video calling. The smart phones are more compatible to 3G services as the applications on a smart phone require high data speed. 4G seems to be a very promising generation of wireless communication

that will change the people's life to wireless world. There are many striking attractive features proposed for 4G which ensures a very high data rate, global roaming etc.

8. REFERENCES

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